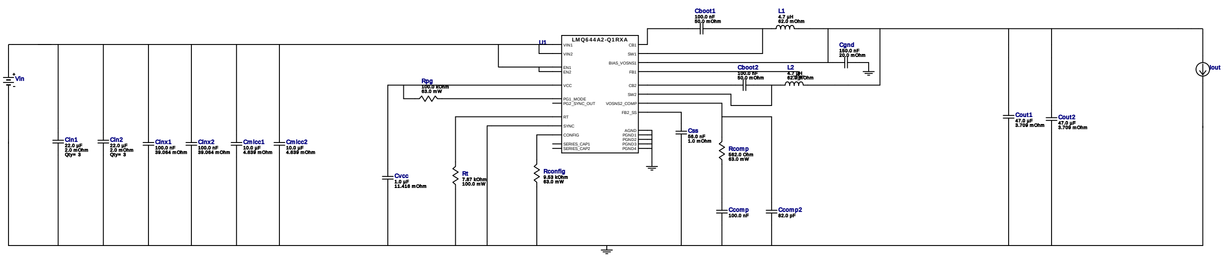
VinMin = 4.0V
VinMax = 16.0V
Vout = 3.3V
Iout = 2.0A

Device = LMQ644A2QRXARQ1
Topology = Buck
Created = 2024-09-08 15:51:59.940
BOM Cost = $6.04
BOM Count = 26
Total Pd = 0.27W

WEBENCH ® Design Report

Design : 7 LMQ644A2QRXARQ1
LMQ644A2QRXARQ1 4V-16V to 3.30V @ 2A



Design Alerts

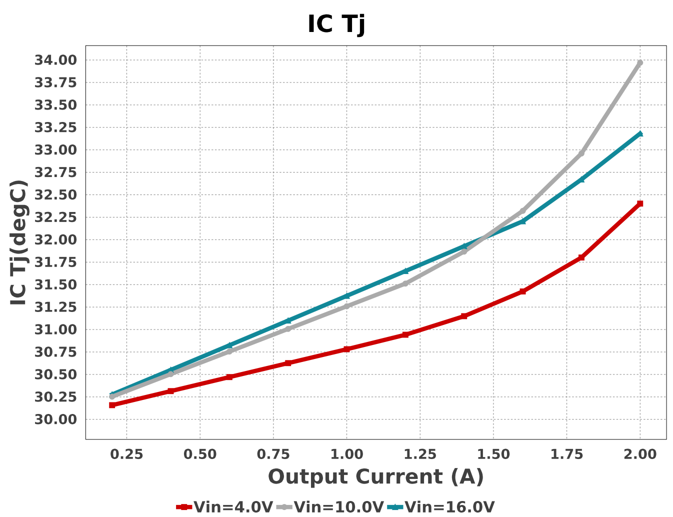
Component Selection Information

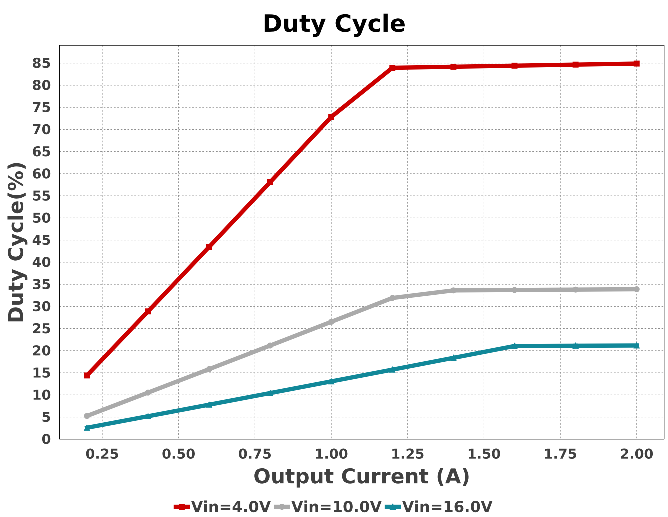
The LMQ644A2-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

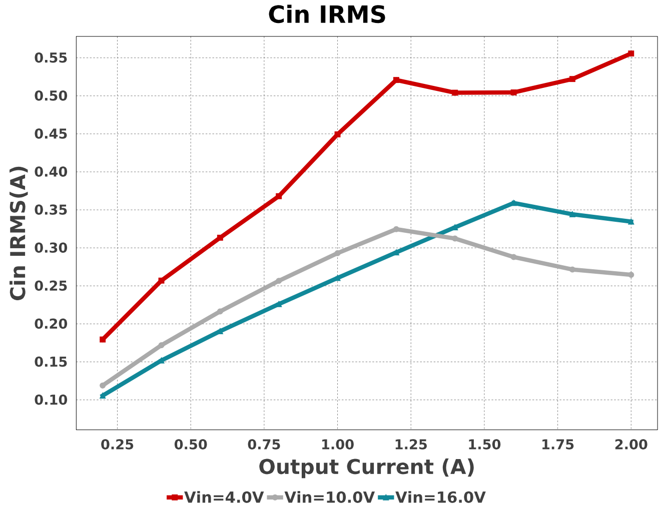
Electrical BOM

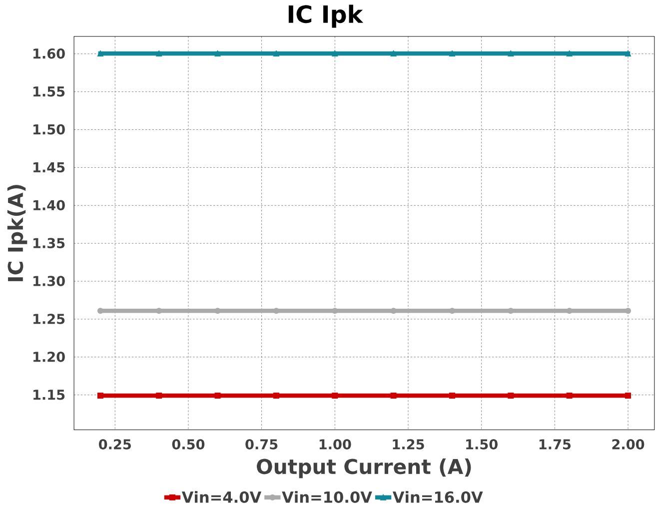
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot1	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cboot2	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm^2
Ccomp2	Samsung Electro-Mechanics	CL02C820JQ2ANNC Series= C0G/NP0	Cap= 82.0 pF VDC= 6.3 V IRMS= 0.0 A	1	$0.10	01005 2 mm^2
Cgnd	MuRata	GRM188R71E154KA01D Series= X7R	Cap= 150.0 nF ESR= 20.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm^2
Cin1	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	3	$0.23	1210 15 mm^2
Cin2	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	3	$0.23	1210 15 mm^2
Cinx1	TDK	C1005X5R1H104K050BB Series= X5R	Cap= 100.0 nF ESR= 39.064 mOhm VDC= 50.0 V IRMS= 814.67 mA	1	$0.02	0402 3 mm^2
Cinx2	TDK	C1005X5R1H104K050BB Series= X5R	Cap= 100.0 nF ESR= 39.064 mOhm VDC= 50.0 V IRMS= 814.67 mA	1	$0.02	0402 3 mm^2

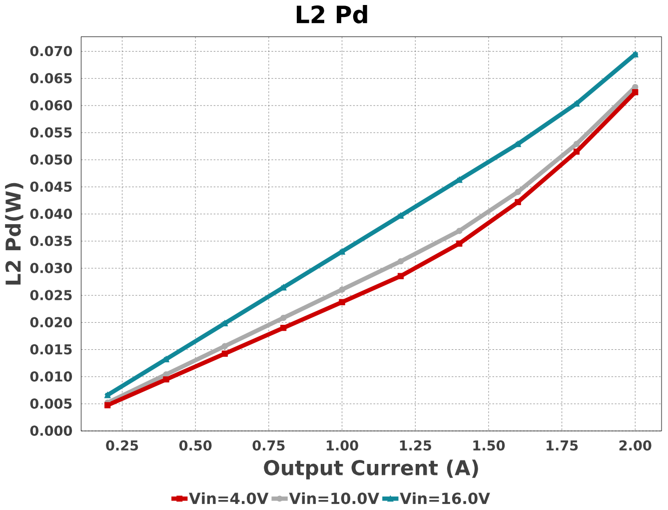
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cmlcc1	TDK	C1608X5R1E106M080AC Series= X5R	Cap= 10.0 uF ESR= 4.639 mOhm VDC= 25.0 V IRMS= 2.4141 A	1	$0.18	0603 5 mm^2
Cmlcc2	TDK	C1608X5R1E106M080AC Series= X5R	Cap= 10.0 uF ESR= 4.639 mOhm VDC= 25.0 V IRMS= 2.4141 A	1	$0.18	0603 5 mm^2
Cout1	MuRata	GRM31CR61A476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.709 mOhm VDC= 10.0 V IRMS= 4.2862 A	1	$0.21	1206_190 11 mm^2
Cout2	MuRata	GRM31CR61A476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.709 mOhm VDC= 10.0 V IRMS= 4.2862 A	1	$0.21	1206_190 11 mm^2
Css	MuRata	GRM188R71C563KA01D Series= X7R	Cap= 56.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
Cvcc	TDK	C1005X6S1C105K050BC Series= X6S	Cap= 1.0 uF ESR= 11.416 mOhm VDC= 16.0 V IRMS= 1.483 A	1	$0.02	0402 3 mm^2
L1	TDK	VLCF4028T-4R7N1R5-2	L= 4.7 µH 62.0 mOhm	1	$0.37	VLCF4028 25 mm^2
L2	TDK	VLCF4028T-4R7N1R5-2	L= 4.7 µH 62.0 mOhm	1	$0.37	VLCF4028 25 mm^2
Rcomp	Vishay-Dale	CRCW0402562RFKED Series= CRCW..e3	Res= 562.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rconfig	Vishay-Dale	CRCW04029K53FKED Series= CRCW..e3	Res= 9.53 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Yageo	RC0603FR-077K87L Series= ?	Res= 7.87 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LMQ644A2QRXARQ1	Switcher	1	$2.80	RXA0024A-MFG 51 mm^2

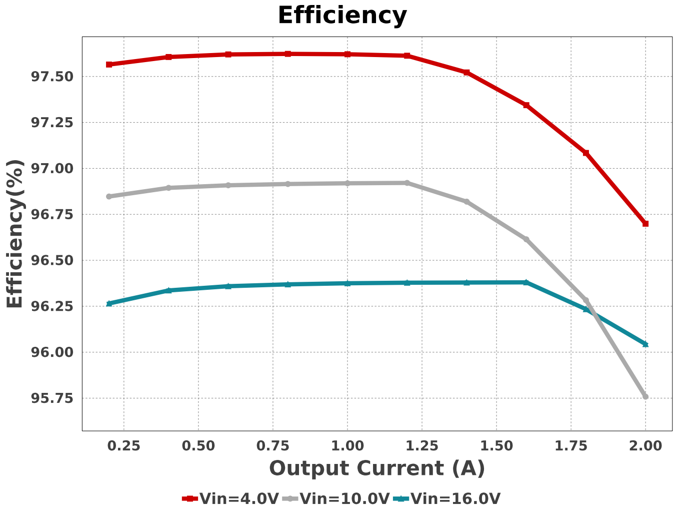


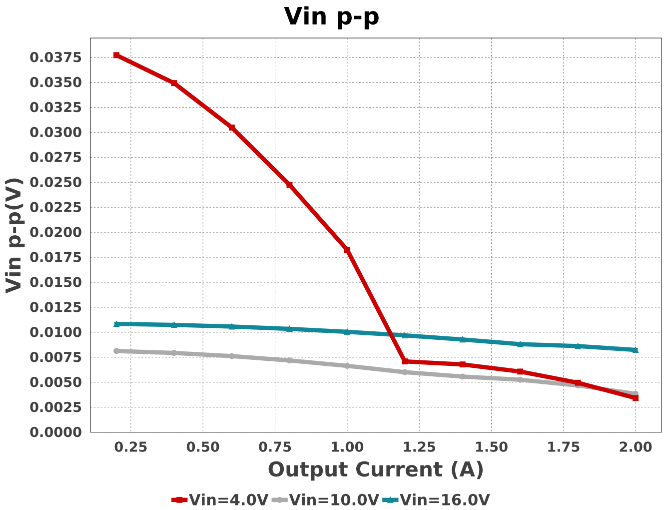


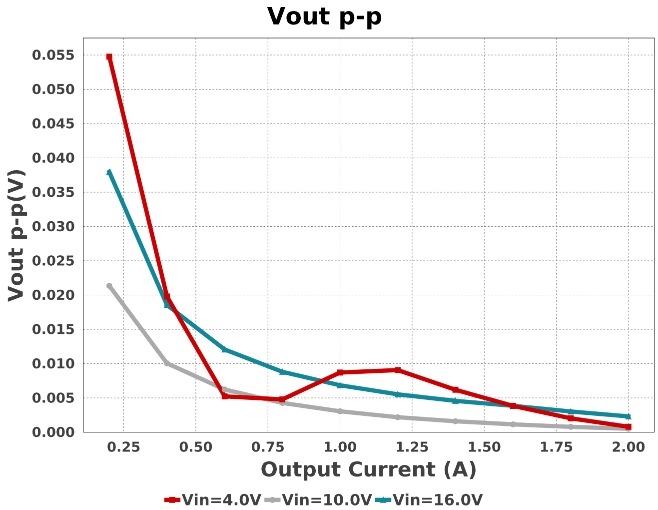

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V


IC Ipk
IC Ipk(A)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V

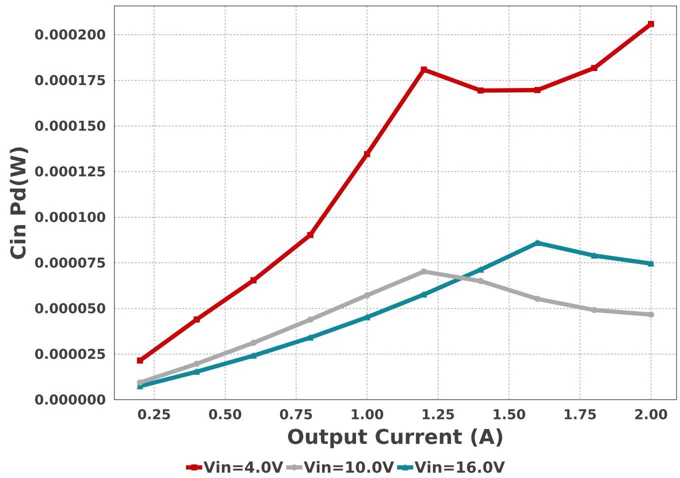

L2 Pd
L2 Pd(W)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V


Efficiency
Efficiency(%)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V

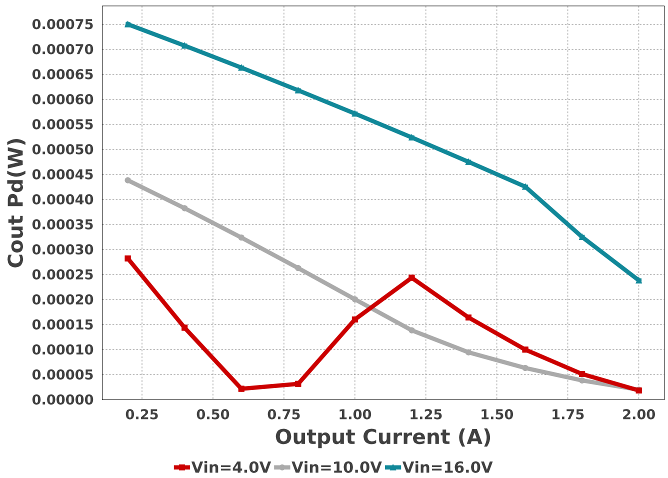

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V


Vout p-p
Vout p-p(V)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V

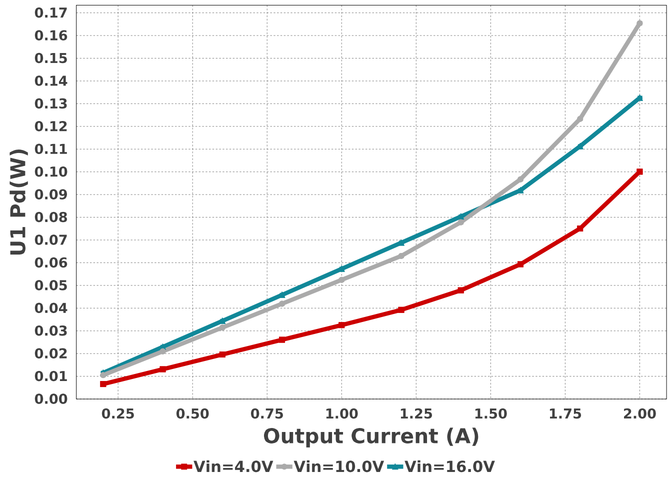
Cin Pd



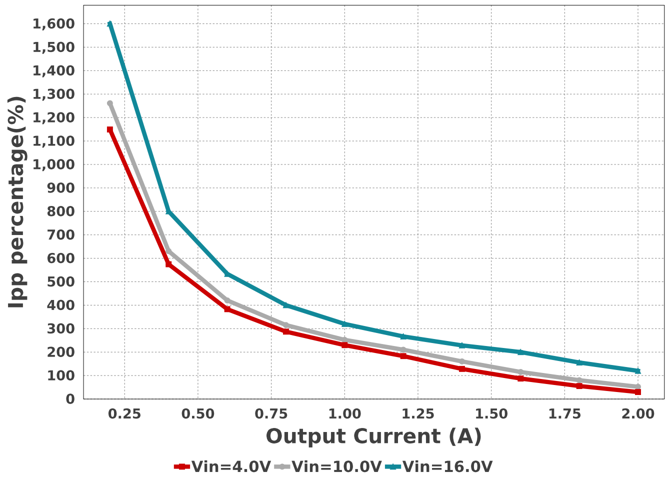
Cout Pd



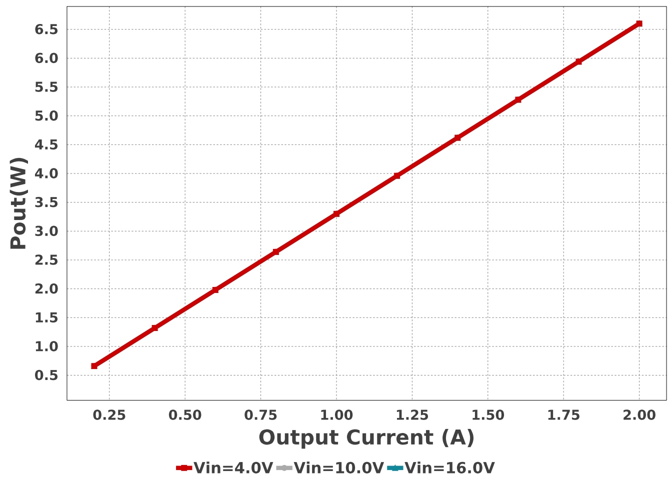
U1 Pd



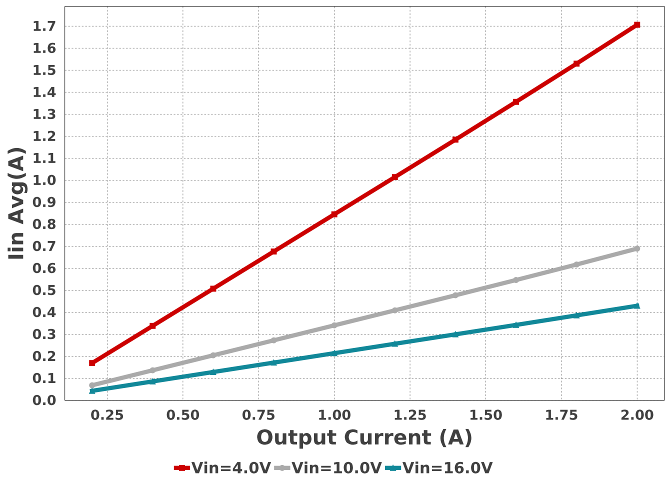
Ipp percentage

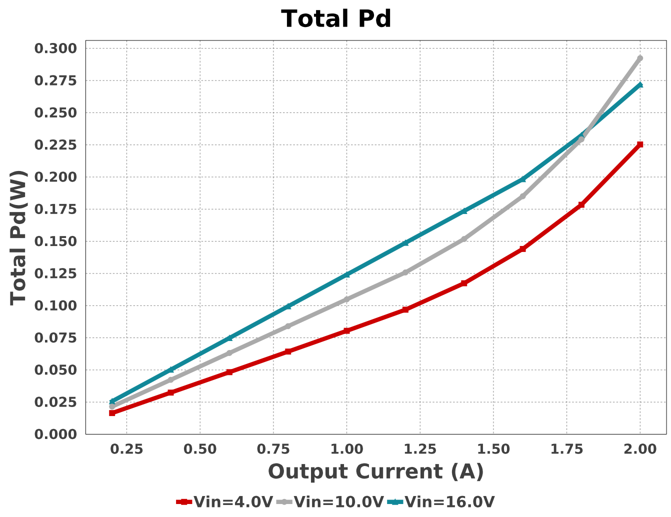


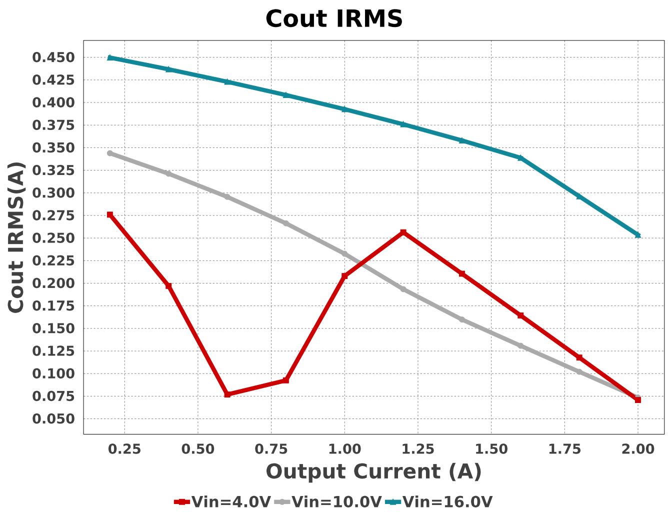
Pout

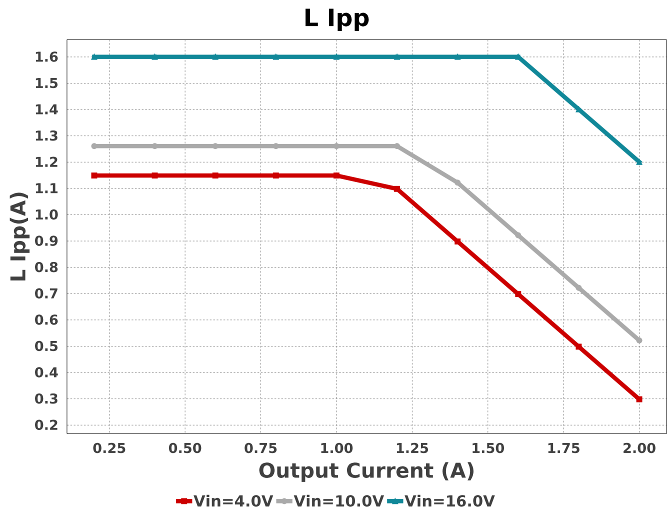


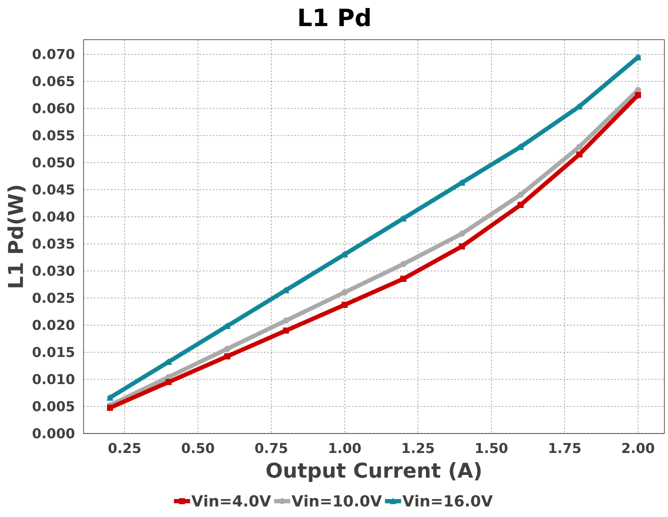
Iin Avg

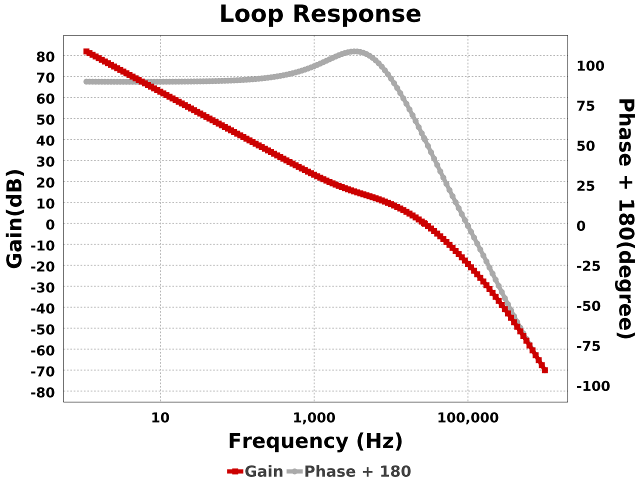


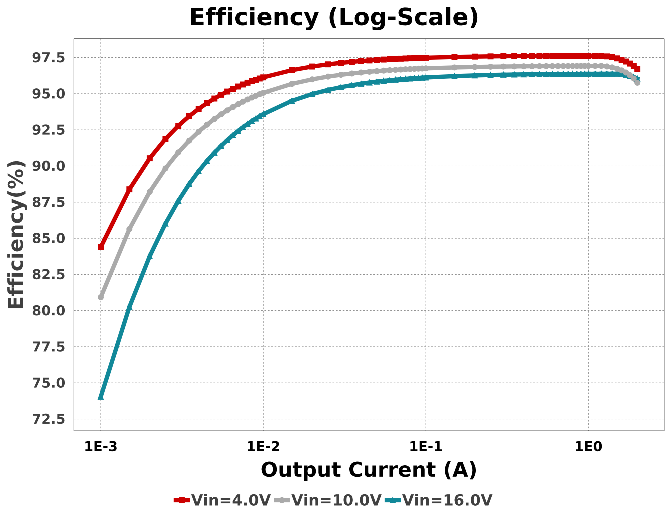












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	334.536 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	74.61 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	253.556 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	238.45 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	1.6 A	IC	Peak switch current in IC
6.	IC Tj	33.181 degC	IC	IC junction temperature
7.	ICThetaJA Effective	24.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
8.	Iin Avg	429.49 mA	IC	Average input current
9.	U1 Pd	132.56 mW	IC	IC power dissipation
10.	Ipp percentage	120.084 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)

#	Name	Value	Category	Description
11.	L Ipp	1.201 A	Inductor	Peak-to-peak inductor ripple current
12.	L1 Pd	69.45 mW	Inductor	Inductor power dissipation
13.	L2 Pd	69.45 mW	Inductor	Inductor power dissipation
14.	Cin Pd	74.61 µW	Power	Input capacitor power dissipation
15.	Cout Pd	238.45 µW	Power	Output capacitor power dissipation
16.	L1 Pd	69.45 mW	Power	Inductor power dissipation
17.	L2 Pd	69.45 mW	Power	Inductor power dissipation
18.	Total Pd	271.85 mW	Power	Total Power Dissipation
19.	U1 Pd	132.56 mW	Power	IC power dissipation
20.	BOM Count	26	System Information	Total Design BOM count
21.	Duty Cycle	21.171 %	System Information	Duty cycle
22.	Efficiency	96.044 %	System Information	Steady state efficiency
23.	FootPrint	270.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	472.72 kHz	System Information	Switching frequency
25.	Iout	2.0 A	System Information	Iout operating point
26.	Mode	PFM	System Information	Conduction Mode
27.	Pout	6.6 W	System Information	Total output power
28.	Total BOM	$6.04	System Information	Total BOM Cost
29.	Vin	16.0 V	System Information	Vin operating point
30.	Vin p-p	8.232 mV	System Information	Peak-to-peak input voltage
31.	Vout	3.3 V	System Information	Operational Output Voltage
32.	Vout	3.3 V	System Information	Operational Output Voltage
33.	Vout Tolerance	363.636 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
34.	Vout p-p	2.305 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	16.0	Maximum input voltage
VinMin	4.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	LMQ644A2-Q1	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

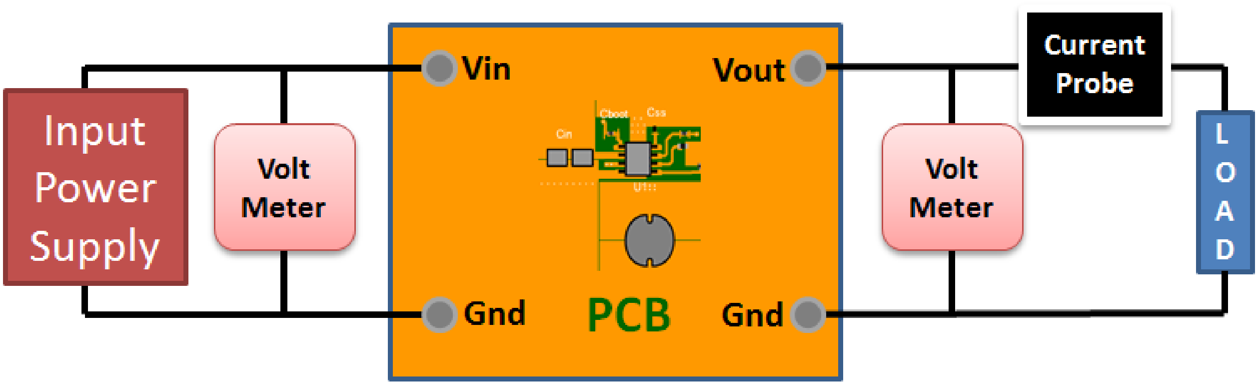
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 4.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. The LMQ644A2-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

2. Master key : 27AFC3A06A218B6F8EA41ED3B4C0DDB7[v1]

3. **LMQ644A2-Q1** Product Folder : http://www.ti.com/product/LMQ644A2%2DQ1 : contains the data sheet and other resources.

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